

WHAT ARE CLAIMED ARE

1. A tunneling junction element comprising:

a substrate;

a lower conductive layer formed on said substrate;

5 a first oxide layer formed on said lower conductive layer and having a non-stoichiometric composition;

a second oxide layer formed on said first oxide layer and having a stoichiometric composition; and

an upper conductive layer formed on said second oxide layer,

10 wherein said first oxide layer is oxidized during a process of forming said second oxide layer and has an oxygen concentration which is lower than an oxygen concentration of said second oxide layer and lowers with a depth in said first oxide layer, and said first and second oxide layers form a tunneling barrier.

15 2. A tunneling junction element according to claim 1, wherein said lower conductive layer has a natural oxide film formed on a surface of said lower conductive layer, and said first oxide layer has an oxygen concentration lower than an oxygen concentration of said natural oxide film at an interface with said lower conductive layer.

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3. A tunneling junction element according to claim 1, wherein said lower conductive layer is a conductive layer with a surface natural oxide film being removed, and said first oxide layer has an oxygen concentration lower than an oxygen concentration of said removed natural oxide film at an interface with said
25 lower conductive layer.

4. A tunneling junction element according to claim 4, wherein the oxygen concentration of said first oxide layer has a value substantially negligible at the interface with said lower conductive layer.
- 5 5. A tunneling junction element according to claim 1, wherein said lower conductive layer includes an antiferromagnetic layer and a ferromagnetic layer, and said upper conductive layer includes a ferromagnetic layer.
6. A tunneling junction element according to claim 5, wherein said lower
- 10 conductive layer further includes an electrode layer formed under said antiferromagnetic layer.
7. A tunneling junction element according to claim 1, wherein said first and second oxide layers are aluminum oxide layers.
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8. A tunneling junction element according to claim 1, wherein said second oxide layer has a thickness of about 0.5 nm to about 2.5 nm.